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Research Paper :

Welding science the need of farmers for repair of farm tools

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ABSTRACT

Agricultural machines are largely fabricated, by village craftsmen and small-scale industries. Tractor, engines and oil mills are manufactured by organized sectors. The small-scale industries seldom have R/D facilities and they depend upon public institutions for the advance technology. This paper focused on the advance of arc welding technology e.g. electric arc welding, gas metal arc welding, tungsten arc welding, submerged arc welding etc, to improve the mechanical properties such as strength, ductility hardness etc., Microstructure, Heat-affected zone and welded structure of farm machines

Key words : Arc welding, Farm tools, Mechanical properties, Shielding gases

In the field of agricultural engineering as arc welding is applicable in various agricultural equipments like toothed spade, puddler, cultivator, tillage machine, plough, harrow, tractor cage wheel etc. Most of these equipments comes direct contact with soil that results maximum stress on the surface region in contact with soil, overall design, quality. Productivity of such equipments depends on the welded structures. The welded structures can be improved by proper selection of welding technique with controlling various welding parameters, material selection, welding electrodes, flux etc. Many researchers have worked and designed new techniques by adapting traditional harvesting to examine effect of prominent tillage packages comprising of different combination of tillage practices on rice residue incorporation in salty clay loam soil compared with conventional practice. Power tiller and tractor drawn improved equipment for seedbed preparation and sowing of lentil crop have been found efficient, high yielding and economical. And the design of seedbed preparation by using a pair of bullocks and a straw push-trough for direct drilling of wheat under paddy residue conditions. Farm machinery (except tractor and power tiller) as one of 836 reserved items are largely manufactured in small scale industries which employ common type of general purpose machine tools such as lathe, drill, grinder, milling, shearing arc welding etc. On agriculture machinery the fatigue cracks and failure commonly starts at weld. Welds are failed frequently at abrupt charges in geometry and usually aggravate the stress concentration (Das, 1997). The current study presents the application of welding techniques in the field of agricultural engineering for design development and maintenance of farm equipments. The various arc-welding techniques discussed here are Electric arc welding, TIG, MIG, PAW, SAW etc. are the most efficient welding techniques used during fabrication. To improve the quality and overall productivity it is required to select the Shielding Gases for Welding. The purpose of shielding gas in GMA, FCAW or GTA welding process is to shield the weld pool and molten filler wire from atmospheric oxygen and nitrogen, The main gases used in the formulation of shielding gases are: argon, helium, carbon dioxide, oxygen, hydrogen. These gases form the basis of the mixtures used in the Agroshield, stainshield and Specshield range designed to best meet the needs of welding technology. To stabilize the arc, provide the desired depth of penetration, and in GMAW, facilitate the required form of metal transfer. The functions affected by such factors as: material to be welded, process chosen, material thickness, metal transfer rate, material transfer mode, weld position, weld economics, type of electrode wire, finish required. All developed countries share a need for improved productivity in arc welding production much attention is being given to the means by which arc welding task may be mechanized or automated. Although technical, economic and social circumstances differ widely, successful Japanese and European developments in advanced welding have a number of common features. Broadly speaking these include the following aspects.

– *Product oriented development*:- a willingness to ask (and answer) basic questions regarding product function, design and production methods

– The use of appropriate rather than necessarily advanced technology

– A need and ability to ensure the acceptance and successful adoption of any new production approaches which may be found necessary.

Some efforts to convert from manual welding using covered electrodes (MMA) to semi-automatic using gas shielded arcs (GMA) were made in order to increase the efficiency of welding production and effect man power saving. The increase in semiautomatic and automatic arc welding equipment is attributed to the following

– Efforts to save manpower and to improve efficiency were required to counter balance the sealed down economy.

– Welding quality needed to be improved as material to be welded from plain carbon steel to high-grade steel, from steel to non-ferrous material and from thick plate to thin plate.

– With the increasing application of electronic in welding equipment the functions and accuracy increased. It also facilitated semi and full automation.

In production of an engineering component or structure, whatever the method of fabrication, there are many factor governing the choice of suitable material e.g avalibility, cost tensile fatigue and creep strength etc. When designing for farm machines fabrication, two important additional factors must be considered weldability of the material and the properties of the welded joint. In literature the study of weld metal and HAZ properties for various grades of steel are studied (Nadkarni, 1988; Das, 1977; Kolhe *et al.*, 2004; Harman, 1967; Seferian, 1962; Eroglu and Aksoy, 2002) by taking CVN test, hardness test, and optical micrograph, factograph to observe the mechanical properties, fracture features correlation between microstructure and mechanical properties etc.

The welding electrode consists mainly a mild steel core wire of closely controlled composition having a concentric covering of flux or other material which will melt uniformly with the core wire and form a partly vaporized and partly molten screen round the arc stream. This shield protects the arc form contamination by the atmospheric gases (Nadkarni, 1988).

Efficiency of arc welding:

The efficiency of arc welding depend on the following factors:

Welding parameters:

The various welding parameters in arc welding are current voltage travel speed, nozzle to plate distance (Nadkarni, 1988) as in literature many authors discussed about the welding parameters it has the effective role to get the quality weld as well as to get the improved mechanical properties and productivity.

Type of material:

Material to be welded is also one of the most important consideration during welding, while design of farm machines case hardened steel is prepared for getting improved mechanical properties and microstructures. Material finds an important place in design of agriculture equipment. The performance and longevity of a machine depends largely on the type and quality of materials used in the parts (Das, 1997).

Penetration:

The overall efficiency of the welding joint depends upon the welding conditions, better penetration, more robust welded joints are to be obtained. The various patterns of penetration are shown in Fig 1. From figure it was observed that higher heat input higher penetration was noted and for increase in current for lower voltage and travel speed causes the defective welded joint while lower current and higher travel speed results the weaker in strength (Dass 1997).

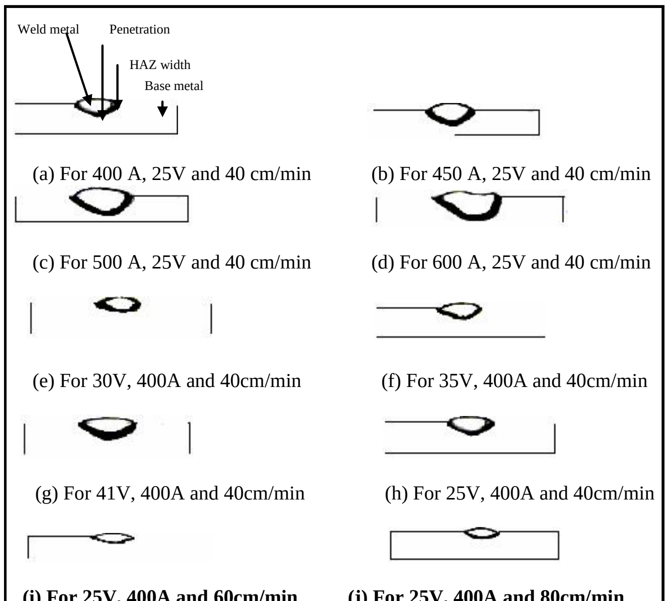

Fig. 1 : Penetration patterns of SAW bead, for various current, voltage and travel speed

Heat-affected zone:

The most important and sensitive concept in welding which is concerned with overall efficiency and productivity, consists of following zones and phases

Sub-zones	Phases
Partially transformed zone	Ferrite,Pearlite,upper banite auto tempered or high carbon martensite
Grain refined zone	Fine grain ferrite and pearlite
Grain Coarsened very fast	cooling massive ferrite with either fe3C or austenite between fingers of ferrite.
Medium high cooling	Pearodic pearlite
Medium slow cooling	weld ferrite and pearlite
Slow cooling	Ferrite pearlite

The various sub zones and microstructures are shown in Fig. 1 and 2.

Fig.3 shows the microstructure of various regions of welded joint. Etching shows the large number of runs used to make the weld .The effect of successive runs on the heat affected zone of parent metal is shows by the alteration of stained areas, the latter indicating the tendency for the structure to be normalized.

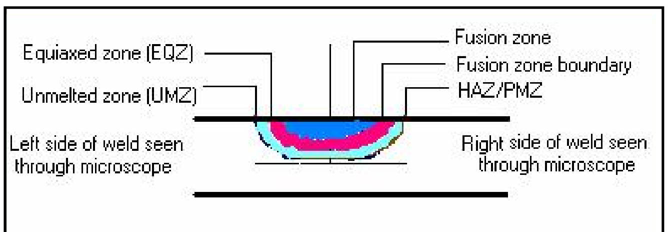

Fig. 2 : Nomenclature for Various welding regions

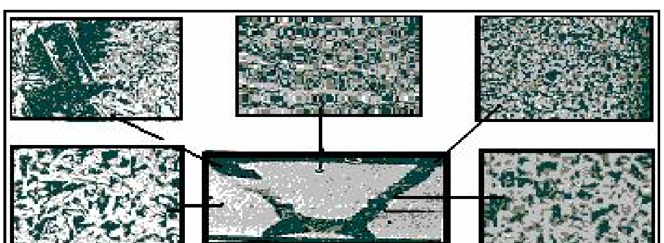

Fig. 3 : Microstructures of welded and heat affected zone of welded joint

– Junction zone: coarse over heated structure with fine aggregate, probably troosite.

– Columnar structure of final run. The weld centre has a fine ferrite structure

– Center of the heat-affected zone: fine ferrite pearlite-pearlite structure

– Boundary of A1-A3 zone: fine coarsened structure

– Unaffected parent metal: ferrite pearlite structure

Mechanical properties:

It plays an important role in Farm machines, as after welding the mechanical properties change completely. It is very important to control these properties, as the total life as well as quality of arc welding, depends on properties like; strength, ductility, tensile strength, hardness etc.

METHODOLOGY

The metal arc welding process consists broadly in the provision of a highly concentrated source of heat that will melt to a controlled depth, the surface of the parent material, at the same time that will melt a mild or other wire which when covered with suitable slag forming material is known as covered electrode. The approximate striking arc voltage characteristics of the six different types of electrode covering are given below in the Table 1.

Table 1 : Striking arc voltage characteristics of different types of electrode

Electrode class	Striking voltage	Arc voltage
1	80	38
2	45	23
3	50	24
4	60	35
5	45	25
6	70	24

Striking voltage are those below which there is a difficulty in iniating the arc. For satisfactory working when using A.C. the open circuit voltage of the transformer should be about 25v higher. The amount of current required for an electrode varies not only with the size of the wire forming the core of the electrode but also with the type of covering electrode with covering containing large quantities iron powder may be used at current up to 50% higher than the values in the Table 2.

The experiments were carried out on mild steel plate using Manual Metal Arc Welding by varying current and using copper coated electrode with the addition of various

Table 2 : The Approximate current values for various sizes of electrode

Size	Typical average amperage	Approximate range amp
12 SWG	80	65-90
10	115	95-130
8	170	145-190
6	210	180-230
4	260	210-290
¼-in	290	240-330

alloying elements. The details of various alloying elements are given in the Table 3.

Table 3 : Details of various alloying element

Elements	% of alloy element
Chromium	0.9
Columbium	0.7
Vanadium	0.8
Molybdenum	0.4
Carbon	0.8
Ferrous	(rest)

After welding samples were prepared for various current, voltage and travel speed parameters. The various samples were prepared by dry polishing the surface of specimens with various grades of polish papers. Finally the specimens were etched by 2% nital and then washed off. Then the specimens were dried by means of blower and the microstructure of specimen was recorded by means of Metallurgical Microscope and pixel view software. Then the specimens were tested under Rockwell hardness machine to find the hardness of surface and second layer surface. The various hardness for weld surface and second layer surface are shown in Table 4.

Table 4 : Current vs hardness (RHN-B)

Current (Amp)	Second Layer	Surface
150	57	63
175	52	63.5
200	55	63.2
225	54	62
250	53	61
275	52	60.5
300	51	60.7
325	50	59
350	50.5	58

RESULTS AND DISCUSSION

The efficiency of arc welding can be improved by selecting the electrodes coded as per ASTM and selection of appropriate voltage and current value for the coaded electrode for getting better penetration, bead characteristics and heat affected zone the role of coded electrode is very important and the corresponding and required voltage and current are shown in Fig. 4.

Fig. 4(a) shows the variations against the various class of electrode and the voltage, the lowest value of voltage required to develop the striking arc and the maximum value shows the arc voltage. These are the required values while selecting the welding parameters so as to improve the quality and efficiency of welded joint and for improving the mechanical properties. While Fig. 4(b) shows the variation of current and approximate current during welding because it was observed that there are variations in current during welding due to many parameters like properties of welded metal, atmospheric condition etc. As arc welding in the field of farm machinery design has a huge application like surfacing, hard facing of farm machinery fabrication etc. Welding efficiency mostly depends on the mechanical properties and microstructure of heat affected zone, as the HAZ region is the most sensitive zone in the welded joint. From Fig. 4 it is seen that the second layer hardness is less than the surface hardness of weld metal. It happens due to addition of alloying elements and varying dilution ratio of welded metal it also improved the microstructure of weld surfaces. After seeing the microstructure of the welded surface it is seen that hardness is obtained due to the carbide formation in the matrix of the surface of parent metal. If the distribution of carbides in the matrix are uniformly distributed the harness value tends to be good. From hardness values and microstructures it can be seen that with increase in current there is a slight decrease in the hardness as shown in Fig. 5.

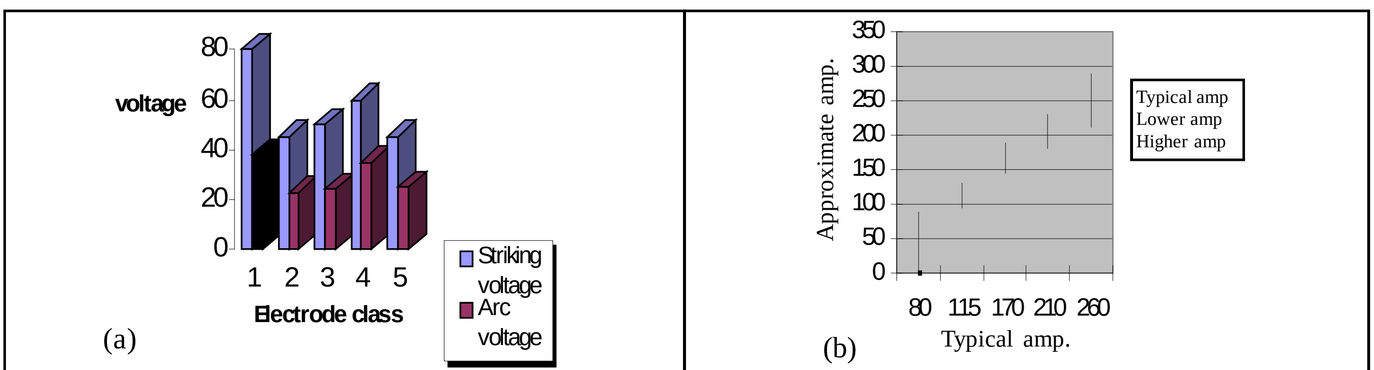

Fig. 4 : (a) Influence of electrode class on voltage
(b) The approximate current values for various sizes of electrode

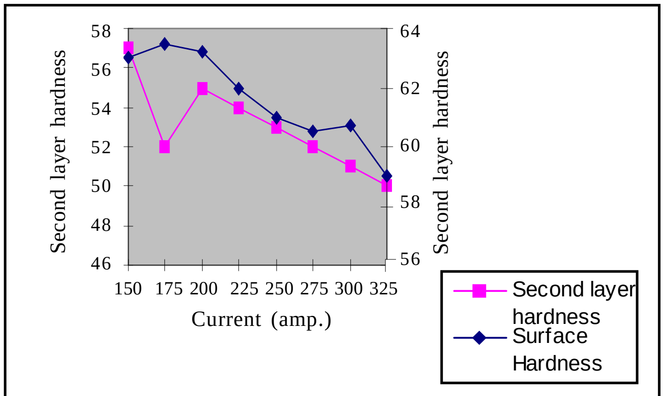

Fig. 5 : Influence of current on hardness

Effect of alloys on surfacing:

From above investigation it is seen that if we incorporate the elements like chromium, vanadium, columbium in the surface of upper surface of deposited weld good hardness values can be obtained and surface can be hardened at desired value. In this experiment, electrode with alloying elements such as Molybdenum, Chromium, Vanadium, Columbium and Carbon has been used. From graph, it can be interpreted that as the current is increasing the hardness value of surface as well as the layer to second layer decreases because the carbides formed by these alloying elements didn't evenly distributed in the matrix of parent material. Also the percentage dilution increases with increase in current. So it is strongly recommended that the current should be kept between 150-175 Amps as shown in Fig. 5.

Conclusion:

From this study it is concluded that arc welding has huge effect on the farm machines as the total productivity, cost quality and overall mechanical properties of farm machines design are closely related to the type of welding process selected and the various parameters like striking voltage, arc voltage, current, choice of material, flux material used etc. If we incorporate elements like chromium, vanadium, columbium in the surface of upper surface of deposited weld good hardness values can be obtained and surface can be hardened at desired value. As in previous available literature it was maintained that agriculture machinery fatigue cracks and failure starts at weld. So to minimize these failure further study like study of microstructure, mechanical properties, heat affected zone will be possible, which would help to enhance the productivity of agricultural machines and reduction in total cost.

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REFERENCES

Das, P.K. (1997). *Pre production development of Agriculture machines*. Manual on Design and Development of Agriculture machines, Technology Transfer Division, CIAE, Bhopal.

Das, P.K. (1997). *Material selection and souring*. Manual on design and development of Agriculture machines, Technology Transfer Division, CIAE, Bhopal.

Eroglu, M. and Aksoy, M. (2002). Effect of Nickel on microstructure and mechnical properties of heat-affected zone of low carbon steel. *J. Material Sci. & Technol.*, **18**(1) : 35-40.

Kolhe, K.P., Datta, C.K. and Powar, A.G. (2004). Effects of heat input on the microstructure and heat affected zone of mild steel. Proceeding of Seminor, Shimoga Karnataka

Nadkarni (1988). Modern Arc Welding Technology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Rautaray, K. (1997). Agriculture Machines –failure analysis and prevention. Manual on Design and Development of Agriculture machines, Technology Transfer division CIAE Bhopal

Rowland Harman, C. (1967). *Hand book for Welding Design*. Sir Issac Pitman & Sons Ltd., for the Institution of Welding London, **1**(2) : 1-18

Seferian, D. (1962). *The Metallurgy of Welding*, Champan and Hall London.

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