A Comparative Experimental Study with and Without Epoxy Bonded Thin Sheet AISI 304 TIG Welded Lap Joint

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Abstract: This paper aims to study the analysis of diversified applications of epoxy based materials in the current perspectives of environmental responsibilities as the modernization has imbued so much threats in respect of pollution and global warming. The applications of epoxy has found a niche in the present scenario world-wide. An exhaustive understanding in this respect can claim several advantages in the present century. Thin sheet welding has enormous contributions in various industrial applications. The study revealed that AISI 304 2mm thick sheet epoxy araldite smeared at the boundaries 100mm x 60mm TIG lap weld has ultimate stress of 190 MPa as compared with normal TIG lap weld of having 180 MPa. This also ensures that the epoxy TIG lap joint is advantageous in respect of joint efficiency.

Keywords: TIG, Epoxy resin, AISI 304 stainless steel, Lap joint.

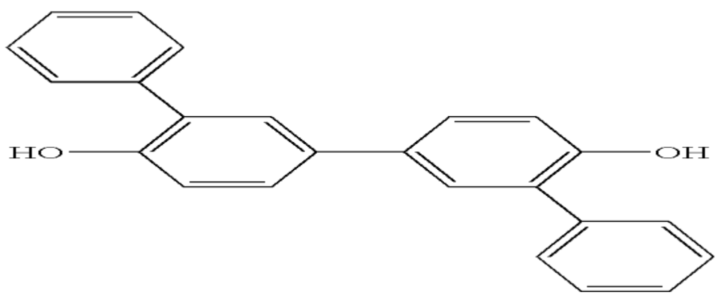
Introduction

In our present living position, epoxy is deeply involved in almost everywhere as one of the most prevalent cross-linked covalent polymers (thermosets). The applications are widely spread from automobile to air-craft industries, electronics, biomedical instruments, and even household and office stationary as well. Welded epoxy materials are very demanding [1]. The fuel consumption can be more economic if the body weight is further reduced. It is said that 1% weight reduction can reduce 1% fuel consumption [2]. Thermosetting epoxy resin as a base can therefore be very suitable for such wide range of applications. This is also a necessity as the natural resources of petroleum reserves is very limited and finite. Besides, by burning fossil fuel, the emissions of carbon dioxide remain trapped in the atmosphere for a long period of time. This leads to global warming which is an alarming issue at present. Kagoshima et al [2] invented an epoxy foamable resin composition.

This composition is used for outer panel of automobiles and it can maintain viscosity under heating condition. It has good adhesivity and anti-rust characteristics.

Corrosion is protected by Epoxy resin (ER) is [3] which was applied on steel surface. The coated steel samples were subjected to acid treatment and aging by UV light for 2000 hrs. Very highly stable film was produced which withstood 1 hr of immersion in a 3wt% NaCl Thermal stability and tensile strength are remarkable in epoxy resins. The epoxy coating – containing zinc phosphate has added advantages for reducing the corrosive effect on carbon steel.

The crystalline epoxy resin obtained by the glycidylation of the compound represented by the following formula fig. 1 [4].



(1)

Fig. 1 Formula of obtained crystalline epoxy resin (ER)

This has got excellent flame retardancy, low water absorption and good impact resistance. Useful as insulating materials of electric and electronic parts, adhesives, coatings, resist materials, and in particular, for optical uses.

Shi et al developed efficient techniques for recycling thermosetting polymers [5].

For joining aluminium AA5754 sheets with thermoset matrix composite consisting of carbon fibre reinforced epoxy resin (CF/epoxy) ultrasonic spot welding was carried out [6]. 34.8 MPa strength in average was obtained. The metallic sheet was plastically deformed with the realization of direct surface to surface contact of aluminum and carbon fibers (CFs) successfully. This has got the proven objective of the reduction of weight achieved effectively.

C. Ageorges, L. Ye [7] carried out an investigation of carbon fibre (CF)-reinforced ploytherimide (PEI) and CF-reinforced epoxy laminates by the resistance welding.

Very high strength (VHS) circular steel tubes is found with an ultimate strength of 1500 MPa [8]. Butt-welded VHS tubes was strengthed by Araldite 420.

Researchers carried out a study to examine the behavior of CFRP strengthened VHS butt-welded circular steel tubes [9].The strength was found enhanced up to 200% with minimum number of four layers of CFRP strengthened with Araldite 420 with a maximum bond length of 75mm.

The adhesive bonding produces better fatigue life, increased weight savings and improved joining tiny and delicate components. Darwish and Ghanya demonstrated a far better flow-in technique than the weld-through technique [10]. The lap joint of 1.5 mm thick low-carbon steel sheets with the structural epoxy resin at room temperature and then was spot welded immediately which is flow-in technique. As compared to the weld –through technique the adhesive material was to be applied and cured at 24^0C for 48 h and then spot welding was being followed. They established that flow-in weld-bond technique was easier, cheaper and having better microstructure with improved hardness.

Materials and Processes

The sheet of AISI 304 stainless steel of 100 mm x 60 mm with 2 mm thickness is used in both Epoxy TIG lap and normal TIG lap joints. The chemical composition of base material and the filler are shown in table 1 and 2 respectively. The fig 2 represents the TIG welding machines manufactured by M/s Virdi, Delhi. Vicker's microhardness tester is used to estimate microhardness with applied load of 500 gm for 20 seconds dwell period and the ultimate yield stress is measured by UTM shown in Table 3. The dumbbells were prepared by wire cut EDM according to ASTM-E8.

Table 1 Chemical composition of base material (% weight)

Materials	Fe	Cr	Mn	Ni	Si	C	P	S	Mo	V	Ti
AISI304	Bal.	17.90	1.88	8.38	0.254	0.043	0.046	0.016	0.224	0.072	0.006

Table 2 Chemical composition of Tungsten filler rod AWS A 5.18 ER 705-2 (% weight)

Materials	Ta	Cr	Mn	Ni	Si	C	P	S	Mo	V	Ti
ER705-2	Bal.	0.15	1.25	0.15	0.54	0.07	0.25	0.45	0.15	0.01	0.08

Fig. 2 TIG 300 phase III

Table 3 Hardness (HV) and UltimateYield Stress (MPa) for both the samples

Sample No.	Description	Hardness (HV)	ULT.Yield Stress (MPa) &El %
1	Epoxy TIG lap weld	195	190 & 8.0
2	Normal TIG lap weld	211	180 & 8.0

Fig 3. Broken tensile samples 1 &2

Results and Discussion

From the experimental observations it is clear from fig 3 that the epoxy smeared at the boundary of the TIG welded lap joint is found with larger ultimate yield stress and lesser hardness as shown in table 3 as compared to similar material normal TIG lap joint. Both broken from the base material. However there is no change in percentage elongation.

Conclusion

In a nut shell, it can be depicted that bonding with epoxies play a substantial role in the manufacturing of advanced engineering materials. There is tremendous scope for applications of such materials in the current century which can give a reasonable solution to the environmental challenges and global warming. The better ultimate stress is obtained with epoxy smearing TIG lap joint for 2mm thickness 304 stainless steel. There is a vast scope for further research in order to achieve numerical modeling especially with soft metals such as aluminum to enable its fuel economy in the automotive sector.

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