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A STUDY ON DISSIMILAR WELDING OF NICKEL-BASE ALLOYS AND CARBON STEEL

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DEDICATION

Dedicated to my parents and my wife whose patience and continuing encouragement constitute a major source of inspiration for me during the whole period of study.

SUMMARY

In chemical and petrochemical industries, economics dictates that a wide variety of dissimilar metal welding is unavoidable. The most important factor involved in the welding of dissimilar metals is the selection of a suitable welding electrode.

This study has been carried out to clarify and evaluate the effect of welding consumable on the properties of dissimilar joints between carbon steel and monel alloy. Also, the effect of post weld heat treatments on the properties of weldments was evaluated. Nickel base electrodes ENiCu-7, ENiCrFe-3 & and autogenous welding have shown to be suitable for most service conditions.

In addition to the evaluation of the corrosion behaviour, optical metallography, tension tests, hardness measurements and X-ray diffraction analysis were employed to qualify the weldments.

The results showed that ENiCu-7 yields the highest corrosion resistance, treatment (1) (heating at 650C^{c} for 30 min. then rapid cooling) gives the highest corrosion rates and mechanical properties meanwhile, treatment (4) (Heating at 300 ^{0}C and held there for 30 min. then heating at 650 ^{0}C and held there for 30 min. then heating at 900 ^{0}C and held there for 30 min. then rapid cooling) gives the lowest corrosion rates and the lowest mechanical properties.

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LITERATURE SURVEY

Strictly speaking almost all joints made with a fusion process are dissimilar. The weld metal is cast and the parent metal is most often wrought. Fine differences in composition are apparent and are usually deliberate. These minor differences are normally taken for granted and a definition of a dissimilar joint as being one between two parent materials of different alloy systems or groups within an alloy system may be adopted [5].

Several examples of dissimilar metal welds are used in process industries.

- In oil gasifigasion plants, there is a certain mixture of gases in each zone of the plant and some regions are exposed to strong corrosive mediums so, there is a need of corrosion resistant material in this region for this reason, dissimilar metal welding between carbon steel and nickel base alloys is essential [6].

- The trend towards higher operating temperatures in nuclear reactor systems necessitates the use of transition joints between combinations of materials such as ferritic stainless steel and nickel base alloys [7].

- In direct fired process heaters, as used in the petroleum and chemical industries, it is common to find tubes of different materials such as mild steel and nickel base alloys. The choice of material is largely dependent on the design metal temperature so, it changes from one part of the heaters to another as the fluid temperature and heat flux change [8].

- In marine service, some parts consist of mild steel which may be adequate while other parts have to be made of nickel base alloys such as monel and inconel where resistance to attack of chlorine ions, mineral acids, nitrides and stress corrosion cracking are required. [9].

- Because of the higher corrosion resistance of nickel alloys than low carbon steel it is always necessary to replace the low carbon steel skirt box of fluorine generators by monel 400 skirt box so, dissimilar metal welding between Monel 400 skirt box and low-carbon steel cover in this case is essential [10].

- Weldements used in nuclear-power reactor systems need more rigid quality standards than those required in conventional power-plant applications. Consequently, there has been considerable interest in the use of nickel base alloys for the construction of certain nuclear-power-plant components, particularly in systems of the pressurised-water reactor type so, it is highly essential to weld carbon steel to nickel base alloys [11].

II-A Types of Nickel Base Alloys

Nickel is an excellent structural metal for many engineering applications. It has the FCC crystal structure so it is tough and ductile. It also has good high and low temperature strength as well as high oxidation resistance and good corrosion resistance for most environments. Few metals can match the attractive engineering properties of nickel. Unfortunately, its greatest disadvantage is its relatively high cost, and thus its use as a base metal for alloys is greatly limited. Nickel-base alloys are therefore used when no cheaper types can provide the necessary corrosion, or heat resisting properties required for special engineering application. There are at least seven nickel alloy systems of major commercial importance [12].

1. Commercial nickel.
2. Nickel-copper alloys.