

I.2: Deployment of low magnetic permeability TIG welding of austenitic stainless steel

Austenitic stainless steel is the preferred material for vacuum chambers of particle accelerators for its excellent ultrahigh vacuum compatibility. The relative magnetic permeability (μ_r) of its weld metal increases due to enhanced delta ferrite content, which might distort the magnetic field in the vicinity. RRCAT has developed the technology of producing sound austenitic weld metals having its relative magnetic permeability very close to that of the parent metal by adding 1.5% to 2% nitrogen in the shield gas (argon) during tungsten inert gas (TIG) welding.

Indigenously developed argon-nitrogen binary gas mixing system (BGMS) has been deployed for welding of the components at the welding shop. The BGMS is based on gravimetric blending. The PLC based system ensures accurate mixing of nitrogen (1% to 5% v/v) and argon (balance). Precise mass flow controllers have been deployed to allow controlled mass flow of each gas. Figure I.2.1 shows the indigenously developed and deployed BGMS setup for TIG welding at RRCAT.



Fig. I.2.1: Indigenously developed binary gas mixing system.

Two components of VECC's reactive ion beam facility, namely beam slit chamber and Einzel lens assembly have been designed for manufacture (DFM) and subsequently manufactured at RRCAT. The technique of low magnetic permeability welding was deployed during TIG welding. The material of construction of both the items is AISI 316L. The filler metal used in the construction is ER 316L. A binary gas mixture of argon and 2% nitrogen was used as shielding gas during TIG welding.

The beam slit chamber is a cuboidal shaped vacuum chamber manufactured from 8 mm thick plate. It is a multi-port vacuum chamber, which includes pumping port and slit port. The overall dimension of the chamber is 511 mm x 340 mm x 242 mm. Gas diffuser system was used in welding of the chamber to inhibit ingress of oxygen while joining perpendicular walls.

Figure I.2.2 depicts the snapshot of the ongoing welding of beam slit chamber by gas tungsten arc welding (GTAW) using the binary gas mixer.



Fig. I.2.2: Welding of beam slit chamber.

The Einzel lens chamber is a cylindrical vacuum chamber, which houses the Einzel lens assembly. The Einzel lens assembly is fabricated from seamless pipe of diameter 186 mm and 6 mm wall thickness. Figure I.2.3 depicts the ongoing welding of Einzel lens assembly using the binary gas mixture.



Fig. I.2.3: Welding of Einzel lens assembly.

The relative magnetic permeability of weld joints has been measured for Einzel lens assembly. It varies between 1.03 and 1.04, which is very close to that of the parent metal and meets the standard specification of relative magnetic permeability <math><1.05</math> for AISI 316L material.

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