



Pipes manufactured by Nuclear Fuel Complex from the UNS N06690 billets supplied by M/s. Midhani

Road Through Indigenization

A new milestone in vitrification of nuclear waste

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Nuclear Recycle Board (NRB) uses a special material viz. UNS N06690/ N06600 for waste management plants (Joule Melter for vitrification of High Level Wastes (HLW)). The Melter used for vitrification operates at a temperature of around 1050°C and the environment is extremely corrosive besides high radiation field. High Ni-Cr based alloy pipes and other fabricated items as per ASTM B-167 e.g. alloy UNS N06690 & UNS N6600 are the suitable materials used for such high temperature and highly corrosive application for immobilization of high level active wastes. These special grade material items used to be imported to meet the department requirement. Since, this is a regular requirement and in order to reduce the level of dependency on imports, a thrust was provided to manufacture them locally.

NRB has now successfully developed and manufactured for the first time the raw material (UNS N06690 ingots) & pipes to meet the existing requirement and the requirement of upcoming waste management plants under Atmanirbhar Bharat scheme. There were three major steps in this work:

- Preparation of technical specifications
- Development, manufacturing and characterization of UNS N06690 billets as raw material manufactured by M/s Mishra Dhatu Nigam Ltd (Midhani).
- Conversion of raw developed material (billets) into tubular products by Nuclear Fuel Complex, a constituent unit of DAE.

Technical Specifications of Product and Challenges

The chemical composition was as per ASTM B-167 with restricted Nitrogen & Titanium content. The mechanical and physical properties conformed to ASTM B-167. The test for

stress corrosion cracking was specified as per ASTM G 28. Specific emphasis was paid to grain size and inclusion rating as the application requires working at 1050 °C. Creep tests as well as stress rupture tests were specified as per ASTM E139-11. For the final products, non-destructive tests (NDT) e.g. ultrasonic test and eddy current tests were specified in addition to specified dimensions and tolerance as per ASTM A-312.

Manufacturing

The billets were manufactured by M/s Midhani in a timely manner for delivery to NFC as per prescribed NRB requirements and specifications. NFC has developed new tooling systems for manufacturing of different pipe sizes, which was a very exhaustive exercise due to multiple attempts for finalizing the tooling design and its manufacturing. The requirement of special testing at elevated temperature (1095 °C) for creep and stress rupture tests for billets and pipes were carried out. It is extremely difficult to conduct these tests for 100 hours as the associated instrumentation and fixtures may malfunction at such elevated temperature. Timely execution for this order was crucial as it was urgently required for ongoing NRB Projects/ Plants.

Testing and Results

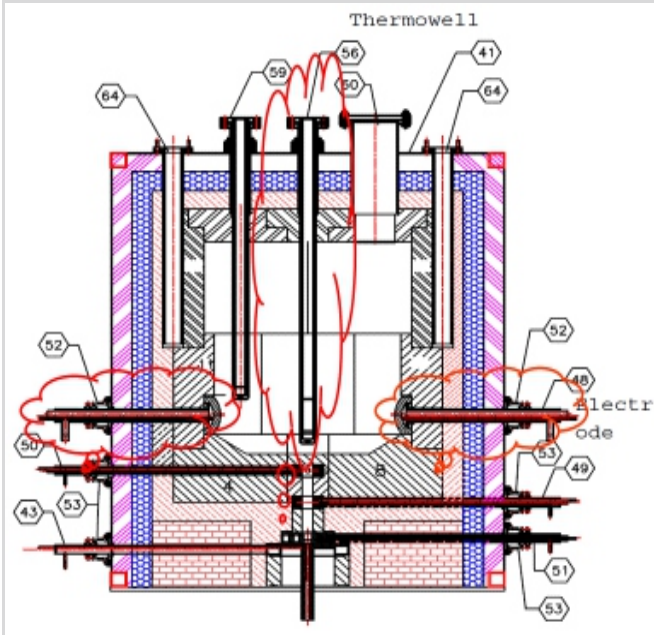
The material was thoroughly tested for quality standards at BARC, NFC, Midhani and at a NABL Lab for raw material as well as for finished pipes. The test results were found within the requirement of the technical specification limits for chemical, mechanical, creep, stress rupture, NDT and corrosion tests.

Significant Achievement

It may be seen that the results of UNS N06690 pipes manufactured for NRB meet the codal requirement of ASTM

B167 and have passed all the special tests such as creep, stress-rupture and SCC to meet the operating requirement of Joule Melters of NRB for immobilization of High Level Wastes.

The total weight of the billets supplied by M/s. Midhani to NFC was 11.4 MTe and the total weight of finished pipes was 7.57 MTe. The expected recovery/ yield in the form of finished pipes (weight) was better than the expected levels and was approximately 66% of the weight of the raw material. The cost of development and manufacturing indigenously is significantly lower than the previous quotations received from foreign bidders for UNS N06690 pipes.

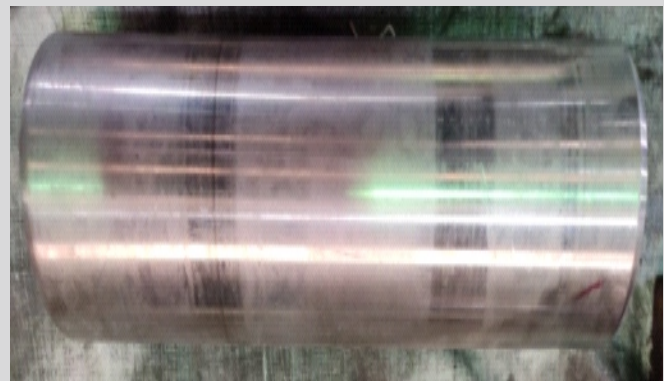


A schematic of Joule Melter.

Acknowledgements

The exercise involving manufacturing of UNS N06690 pipes is comprehensive and at the same time challenging too. NRB received requisite help from various experts and agencies to accomplish the mandate.

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Inconel 690 billet produced by M/s MIDHANI.



The initiation of supply of alloy 690 products. These high value products of strategic importance were produced at Nuclear Fuel Complex facility in Hyderabad.

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