

Major R&D Projects

Establishment of Activated TIG [ATIG] Welding for Orbital Welding of Tubes at Tubular Shop

The newly developed Activated TIG welding process enables full penetration butt welds in single pass in tube joints of wall thickness up to 8 mm with square butt joint preparation.



The technology has been established for similar and dissimilar combinations, successfully. The combinations include the following

- 1.SA 213 Gr. T 11 – Dia 54 x 4 mm, Dia 54 x 5.6 mm & Dia 47.63 x 5 mm
- 2.SA 210 Gr. C – Dia 47.63 x 5 mm
- 3.SA 213 Gr. T 22 – Dia 54 x 4 mm
- 4.SA 213 Gr. T 91 – Dia 54 x 4 mm

The integrity of weld joints and weld metal properties evaluated through RT, Transverse tensile test, bend test, hardness and macro examinations are found to meet ASME requirements.

Benefits::

- The edge preparation time is considerably reduced, as it requires only square butt joint instead of J groove.
- Number of joints per shift increased by 200%.
- Consumption of power, shielding gas and wire reduces by 50%.

Establishment of Abrasive Water Jet Cutting Technology

Water jet cutting systems are versatile and can cut any shape in a single step, and they provide edge quality that typically does not require secondary finishing. These characteristics make water jet cutting an attractive option to reduce cost. Removal of HAZ by grinding, drilling and reaming operation which are currently being done as subsequent operations of Plasma cutting or gas cutting on the LESIGA components for constant load hanger, serrated plates, cam and travel stop plates is eliminated by Water jet cutting technology. Stainless steel circular plates and flanges have also been cut. The adoption of this technology can thus bring in considerable saving in time and cost.



Water Jet cutting is developed for boiler components for the first time in the world.

Development of automated welding system for joining bifurcate assembly

Further to the earlier developed prototype bifurcate welding system, a new automated welding system developed in association with Welding Technology Centre, BHEL, Tiruchirappalli. The system uses root welding by GTAW process and GMAW for filler passes. Significant improvements have been effected with reference to job holding fixture and thus enhancing the productivity many fold. The machine can be used for all the variants of bifurcates that are currently manufactured and also for the future designs.

Development of internal stellite system for Y-type valve body

In the manufacture of Y-type valve to meet the requirement of depositing stellite into a narrow bore of 20 to 40 mm diameter at a depth of 80 to 100 mm, a mechanized internal stellite has been developed for use in production. The stellite metal deposited is found to meet the NDT requirement after machining to the required size as well as the hardness level of 40 Rc. The developed mechanized system has a potential to replace the manual stellite and increase the productivity by 300%.



Friction Stir Welding of palm assembly of Bus Ducts of BHEL, Rudrapur



WRI has established the technology for joining of palm to blanking plate assembly (Aluminum AA 1000) for BHEL, Rudrapur by friction stir welding process. This technology replaces MIG and TIG welding processes being adopted at present. The electrical properties of welded assembly has been evaluated and found satisfactorily.

WRI is the pioneer in developing friction stir welding technology for such T type joints for power plant components in the world.

Development of a Lathe type Rotating Fixture for Welding Bifurcates

Bifurcates are high volume items required in large numbers for every boiler. The volume goes still higher for the higher capacity boilers. Meeting the demand by manual welding will be difficult. WRI has developed a lathe type rotating fixture for bifurcate welding – a step towards the development of a fully automated welding system. The lathe type rotating fixture developed with double end drive and with special holding fixtures at head and tail stocks to align the geometrically irregular components and the hydraulically actuated joint supporting fixture makes the welding easier. Further introducing pulsed GMAW process in place of SMAW further increases the quality and productivity. The lathe type rotating fixture for bifurcate welding also could be used for any tube to tube butt welding application.



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Lathe type rotating fixture for bifurcate welding – a low cost mechanized system has been developed and adopted into production.

Development of Magnetically Rotating Arc Welding System for Welding of tubes



Magnetically Impelled Arc Butt welding equipment is installed at WRI to carry out welding of tube to tube for boiler applications. The process does not use filler material and any surface impurities are extruded during the forging phase. The result is a very fast and reproducible method of welding tubes. It is capable of welding tube to tube or tube to flange and can also weld irregular or non-circular components as well as circular. Welds achieved are free from inclusions and impurities. This process welds a variety of materials including dissimilar combinations. Approval for using this process for Boiler application, is being taken up with Boiler Directorate and also ASME authorities.

Welding Process Monitoring System

A welding parameter recording system has been developed and installed at BHEL, Bhopal to monitor the Narrow Gap Submerged Arc Welding machine parameters. This system is capable of continuous recording of input variables such as welding current, voltage, welding speed/ carriage speed along with the surface temperature of the job under welding. The input parameters are captured using a set of amplifiers and sensors and subsequently converted to digital and transmitted to a personal computer for display, storage and retrieval. The frequency of data collection can be varied from 1 sample per hour to 1000 samples per second. This system also can facilitate trend analysis of weld data. An automatic time stamping is also built in to avoid tampering of actual data. Particulars of operator, job detail and time and duration are recorded for future reference.



Arc welding power source evaluation system



The input welding parameters such as welding current and voltage data are collected dynamically during arc welding processes and the same is analysed for its quality of input. With a data acquisition speed up to 2000 samples per second, the collected data is being analysed using a WRI developed software. The software enables to evaluate the power source characteristics like arc stability, arc ignition, spatter level in a graded index. The system can also be employed to compare and rank a best power source among the lot. In addition, an accepted power source can be used as a bench mark for evaluation of further power sources.

Flux assisted GTAW (Gas Tungsten Arc Welding) of stainless steels

A special welding flux called the Active flux has been imported from the Paton Welding Institute, Ukraine and has been used in GTA welds of stainless steel to improve penetration. The use of the flux enables welding without edge preparation without external filler and enables the joint to be completed with high productivity. Such joints have been tested and good x-ray quality and mechanical properties have been achieved.

Establishment of welding procedure for thick section ceiling girder using Submerged Arc welding



Currently the ceiling girders are fabricated by using SMAW process. To enhance the productivity and to reduce the cycle time at vendors works and at sites, the high productive process such as SAW with cold wire was introduced in the fabrication of ceiling girders made of HSLA steel conforming to EN10025 S420N.

Introduction of butt welded spiral finned carbon steel tubes for HRSG

In this project fatigue studies carried out on spiral fin welded tubes with and without butt joints made by Arc welding. The results of the study show that the spiral fin weld on butt joint can withstand more than 2 million cycles under simulated conditions of fatigue loading. This study validates the use of 23 metre long SFT in HRSGs. This results in considerable reduction in cost and delivery time.



Laser Welding of control valve disk cage assembly

WRI has taken up laser welding of control valve disk cage assembly consists of 7.8 mm stainless steel cage top, 15.2 mm stainless steel cage bottom and four cage stacks of 19 nos of 1.6 mm thick SS disks for Valves department. All cage plates were circumferentially laser welded with each other. All the 20 cir-seam welds with similar and dissimilar thicknesses were realised with consistent penetration and without affecting the grooves in the cage stacks. Two different disk cage assemblies were laser welded and delivered for operational trials at a site. This newly developed technology will improve the reliability and availability and also result in cost savings.

Minimising the extent of corrosion in boiler components by electrochemical techniques.



ORP measurement is an effective tool in water chemistry management for ensuring corrosion prevention due to dissolved oxygen. The dosage of oxygen scavengers and other alkalising amines can be monitored with Oxidation reduction potential of the steam water system. The Electrochemical Potentiostat measures the Oxidation Reduction potential (ORP) of aqueous solutions as per ASTM D 1498. Trial ORP measurements were carried out with various concentrations of hydrazine, ammonia, pH and temperature. On line measurements of Oxidation reduction potential of steam water cycle namely, CEP, Feed water, Boiler water, saturated steam and main steam were measured in Mettler UNIT II. The negative potential of all the samples suggest that the entire water - steam system of the unit is free of dissolved oxygen and hence corrosion propensity due to dissolved oxygen is completely absent. Also inhibitor efficiency evaluation and passivation studies with EDTA chemical cleaning were also studied and characterized by SEM and AFM.

Coldwire addition in Tandem Submerged arc welding implemented.

Coldwire addition in Tandem SAW has been developed at WRI and implemented in Ring headers & Drum shell long seam welding. The procedure has been approved by Director of Boilers, Tamilnadu. This technology will result in 50% reduction in cycle time & energy saving and 40% increasing in productivity.



Optimization of PWHT for P 91 pipe joints

In this project the pipe material of SA 335 P91 size 219 x 25 mm were welded and post weld heat treated at 740 °C/ 2 hr, 760 °C / 2, 3 and 4 hr and the mechanical properties were studied. The pipe joints that were post weld tempered at 740 °C /2 hr, had shown high hardness in the weld compared to other conditions of post weld heat treatments. The toughness of weld metal was poor for the above PWHT. Based on the above experimental work, it was observed that the post weld tempering of weld joints at a temperature of 760 °C leads to better mechanical properties.

Effect of heat treatment on tensile properties of low-hydrogen weld metal deposited using AWS E7018 electrodes for boiler structural steels

The results of effect of heat treatment for boiler structural steels studies provide a validation for our design and production practice of boiler structures like ceiling girders and columns. The fabrication of these components involves welding very high thickness plates. The study undertaken confirms that the tensile strength of weld metal in the PWHT condition is comparable to the tensile strength of the base metal.

Studies to prevent oxidation during root welding of T 91 steel tubes

The root pass of T91 is normally welded using TIG welding with Argon gas back purging to avoid root oxidation. WRI carried out a study on an alternate method of root pass welding using Shield Metal Arc Welding (SMAW) process with special welding consumable from Bohler Thyssen to avoid root purging. Technology for root welding of T91 tubes without Ar gas purging has been established.

Tandem twin wire submerged arc welding technology for ring header welding

In this project, the influence of process parameters of tandem twin wire SAW on the metal deposition rate, dilution, bead geometry, macro, microstructure, hardness and mechanical properties for the steel used in boiler components have been studied. The results are compared with conventional tandem submerged arc welding process to bring out the advantage of tandem twin wire technique.

Studies on ageing and its effect on mechanical properties of P36 steel and it's weldments

3% copper containing Low alloy steel is a candidate material for usage in feed water piping of supercritical boilers. Published reports indicate that this steel may be susceptible to embrittlement during long time ageing. In order to study the same, limited short term ageing tests were carried out on the material and HAZ of weld joint. These joints were welded using TIG and SMAW processes with two different consumables. The mechanical properties of the joints were tested for different post weld heat treatments. The limited study reveals that the embrittlement effect is not significant.

Thermo mechanical simulation of manufacturing processes on P92 & P23 steels

The newly developed P92 and P23 steels undergo significant thermal regimes in the course of fabrication. Various manufacturing processes such as welding, bending, etc. are involved in the conversion of the material into components. The weld thermal cycles significantly influence hardness and toughness of heat affected zone of weld joints. In this project, weld thermal cycles were determined for single pass, multi-pass and repair welds for the typical welding parameters used in pipe welding. The experimental thermal cycles were applied using thermal cycle simulator. The mechanical properties for various welding conditions have been obtained.

Dissimilar Welding of T23 and 347H tubes for Super-heater coils with inconel filler wires

WRI conducted studies on “Dissimilar steel tube welding of T23 + 347H” with inconel fillers and established optimum welding parameters and purging procedures. Mechanical testing of dissimilar metal welding, hot tensile test at 700°C and creep test were carried out. All the metallurgical / SEM studies were carried out and all test results were found to meet the requirement for super heater coil service.

Indentation Creep studies in steels

In this study, the new high temperature (upto 800 °C) creep indentation machine has been developed and applied for establishing Correlation of creep indentation data and temperature. The study has been conducted in various boiler grade steels under simulated conditions. The study also includes metallography and fractography analysis. The system can be used in conducting metallurgical indexing of different boiler grade materials.



Performance Evaluation of Electro Conducting Polymer based Primers Paints for Boiler Structures

A new conductive polymer (poly aniline) based Red Oxide primer paint has been successfully developed. The results of corrosion inhibition studies obtained with this paint were found superior compared to the conventional primer paints. Further tests like salt spray test, humidity chamber test, electro chemical impedance test and outdoor exposure test have proved the efficacy of the formulation. This conducting polymer based paints are eco friendly and have very good corrosion protection.

Major Consultancy Projects

Development of Friction welding procedure

Development of Friction welding procedure for dissimilar joining of Ti - 5 Al - 2.5 Sn to ICSS 321 with pure Al (AA1095) as inter layer and welding of 30 components completed successfully for M/s LPSC, Vallimala.

Repair welding of sickle plates

Consultancy for repair welding of failed Sickle plates at Srisaillam Hydro project for APGENCO was provided.

Consultancy on Quality improvement for ROSA power plant

Two WRI experts visited the Rosa power plant stage I, 2 x 300 MW, set up by M/s Reliance Infrastructure Limited, to provide consultancy on lack of penetration in coal bunker. In addition, during the site visit, WRI experts recommended to provide additional brackets / circular splice plates for effective load transfer from the bunker to the support structure. The boilers have been sourced from M/s Shangai Electrical Works, China.

Failure analysis of Railway Coach

WRI carried out failure analysis for South Central Railway, Hyderabad. The scope of work was to study the failure of a part of under frame structure of a coach due to an accident. The site was visited and samples were identified. Mechanical and metallurgical tests were carried out on the samples to identify the causes for the failure.

Failure analysis of cross country Gas pipe line

WRI has carried out failure analysis of cross country gas line pipes opened out at the weld seams during the process of laying and cold bending, for M/s Engineers India Limited. The pipes were helical welded using fusion welding processes of GMAW and SAW. The material specification & grade of the helical welded pipe is API 5L-X70. The pipes were about 1.7 m dia with wall thickness ranging from 17-20 mm. The pipe material and weld seam was subjected to various mechanical and metallurgical tests. Residual stress measurements and scanning electron microscopy examination were also performed on the pipe and weld material. It was found that the inadequate fusion and bonding of weld and plate edges near the mid thickness of pipe along the seam length caused failure of the line pipe.

Weldability analysis for SAIL's new steel

For Bhilai Steel Plant, SAIL, WRI carried out weldability evaluation, Nil Ductility Transition Temperature Test and Z test on 50 mm thick NV E 36 steel plates and Nil Ductility Transition Temperature Test on 25 mm thick NV E 36 steel plates. The tests carried out at WRI labs were witnessed by M/s ABS, M/s DNV and M/s Bhilai Steel Plant officials.

Welding procedure for automotive component

Resistance seam welding procedure has been successfully developed for fabrication of automotive fuel tank assembly for M/s TAFE, Chennai

Determination of Nil Ductility Transition Temperature

Nil Ductility Transition Temperature Tests were carried out for M/s Bharat Forge and M/s Bay Forge for their components in the presence of NPCIL officials as per ASTM standards to find the suitability of the material for sub-zero temperatures.

Consultancy on Cracking Problem in welding of GX 12 Cr Mo W V Nb N 10-11 Material

Recommendations were made to BHEL, Haridwar to solve the problem of frequent cracking in weld joints of IVCV casting of material GX 12 Cr Mo W V Nb N 10-11, a new material introduced in Dadri project, for the first time by BHEL. WRI prepared the welding procedure including root pass welding parameters, inter-pass temperature, inter-stage inspection, NDT methods, etc. for successful completion of welding at Haridwar.

MOU with BEML

Under MOU project with BEML the following projects were completed.

- Structural failures of boom and bucket link of hydraulic excavators.
- Fatigue Life Analysis of components
- Corrosion test of welded samples.
- Condition assessment of rear axle assembly of dumper equipments

Cracking Problem in high alloy martensitic stainless steel Castings

WRI provided consultancy for solving cracking problems and repair welding procedure of high alloy martensitic stainless steel T3 Bonnet housing castings pertaining to an export contract. After the shop visit, checking of test certificates and procedures, detailed recommendations were given to the customer on casting procedures / parameters, welding procedures / parameters and proper handling and storage of electrodes and chemical composition limit of T3 casting.

Weld Audit at Engineering workshop, Southern Railways

A team visited the Engineering workshop of Southern Railway of Arakkonam to carryout weld audit for fabrication of I beam girders and flash butt welding of rails. WRI made recommendations on improvement in the design of fixtures, clamping arrangements and weld sequencing for distortion control and for quality improvements were made.

Participation on ISRO programme

WRI has participated in ISRO programme by providing consultancy on designing proper weld sequence in fabrication of Mobile Launch Pedestal for M/s ISRO, Sriharikota. The work included monitoring the flatness of Central Annular Structure (CAS) at every stage of welding and give coarse correction depending on the deviation noticed.

