Welding Science and Technology in India

Present status and strategies for the millennium

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There is a rapid growth in welding technology, and all developed countries are reaping the benefits of the advancements, by timely implementation of welding processes and welding consumables, as and when they are made available to the industries. For the past 50 years, we in India are trying to absorb the technology in a limited way. However there exists large gap in various aspects of welding science and technology, which require attention in the new millennium. WRI in the last 25 years tried to develop need-based technology through interaction with various industries. Through the assistance of UNDP, UNIDO, BHEL & GTZ Germany, many projects have been completed in the areas of special purpose welding equipment, welding consumables, weldability studies, in-process quality monitors and weld metal characterization.

A very brief review of the present status in our country reveals that we may have to put lot of effort to bridge the gap in welding technology. In this presentation, some of the important areas where special attention is required are indicated for the consideration in the very near future.

Globalization and liberalization in the last few years influenced welding industry also and a stiff competition made the suppliers to give quality products.

The quality of raw materials in India is not consistent and the welding consumable industry is facing problems in meeting the customers' demand for reproducible quality. There is brain drain among the welding engineers and welders.

In most of the developing countries, there is an increasing trend for mechanization and automation, whereas in India, only in major industries, there is a trend to have selective automation. However the levels are considerably low. Though there are many special purpose equipments developed, they are too expensive to be used in India. Only very few establishments in India also use some of the advanced welding processes. Consumables for TIG and GMAW processes especially for high alloy steels are not available. Non-destructive testing methods for online defect monitoring are yet to be developed in our country.

In our country, there is maximum use of manual metal arc welding (75 to 80%), semi-automatic welding processes (10-15%) and automatic welding process (5 to 10%) find very less use. This provides enormous scope for introduction of low cost automation and selective mechanization in medium and large-scale industries. By this, it may be possible to bring down the usage of manual metal arc welding to the level of 50 to 60%.

We will review very briefly the gaps in welding science and technology, with regard to welding processes, welding equipment, consumables, characterization of welds, simulation and modeling and weld discontinuity characterization.

Many large-scale fabricators are using imported welding equipment and some are facing problems with regard to maintenance as well as availability of spares. For indigenous

development of some of the welding equipment the critical components are required to be imported, such as sensors and seam trackers.

Many advanced welding processes, like electron beam, laser, friction welding, diffusion bonding are all highly capital intensive and also require expertise in using and maintaining these equipment.

These advanced welding processes are finding use only in nuclear & defense, while other industries are using, to a very limited extent. There are also very few jobbing centers in our country for the benefit of users.

Indian welding equipment manufacturers require expertise for microcomputer based weld programmers, CNC systems and various types of sensors.

Special emphasis for automation and robotics is required and some of the problems like electromagnetic compatibility and radio frequency interfacing have to be looked into. In the area of welding power sources, computer based control systems will be of advantage.

There is maximum use of manual metal arc welding, TIG and Gas Metal Arc Welding for low carbon steels in our country, but the consumables especially for other special materials for TIG & GMAW are not available. In the area of electrodes, extra low hydrogen and non-synthetic are not available for special steels. Metal powders required for plasma spray are still imported and these are very costly. Flux cored wires for alloy steels and hardfacing are also presently imported.

Since consumable manufacturers have to rely on the raw materials available in our country, there should be developmental effort in order to find the influence of purity levels of minerals used for flux formulations. An in-depth analysis of slag metal reactions is essential to develop special purpose consumables. In this direction, modeling of element transfer, kinetics in weld pool to predict weld metal chemistry and mechanical properties will be helpful.

Metal powders development for plasma spray is another challenging area and requires expertise to control grain size and shape.

Research work on slag-metal reactions requires special instrumentation for evaluating high temperature properties of slags.

High strength materials will be very useful to reduce the weight of welded assemblies. This also facilitates optimum weld design. Special welding consumables are required to tackle the problems of cracking.

Welding engineers should concentrate on developing expertise to design the products in order to minimize residual stress and distortion. Analysis of dynamic loaded welded structures with regard to life assessment is very important for taking replacement decisions.

Finite element techniques will be very useful for predicting residual stress and distortion while welding with different welding processes. Data generation on fracture toughness values for high strength steels will be helpful for fail safe design.

Defect tolerance using fracture mechanics and finite element methods will be helpful for service life monitoring. Creep damage mechanisms of power plant components require special attention.

The fundamental studies using simulation and modeling will be helpful to study weld bead shape, microstructure, mechanical properties, diffusable hydrogen. These studies can also be extended to advanced welding processes.

In-depth studies are required for generating data on weld pool solidification under various conditions.

On-line monitoring of welding, using special equipments will be helpful to produce quality welds.

Special NDT techniques have to be developed for joints between dissimilar materials. Radiography can be further improved using image enhancing techniques and analysis.

Ultrasonic testing should be fully exploited by gaining expertise in signal analysis. Thermography and radiography, acoustic emission technique should also be used effectively for defect detection.

In order to bridge the technology gap, it is required to have close interaction between various institutions. Dissemination of knowledge will help in utilizing the results. Since information technology today is growing at a very rapid pace, it has to be exploited fully for welding technology. The funds allocated for R&D also should be properly utilized for need-based research and development.

There should be very close interaction between industries and R&D labs. R&D labs should interact with institutions in order to generate useful projects. Industries also should come forward to sponsor R&D projects, which are of current relevance.

Knowledge dissemination through workshops, seminars, will help to a large extent in using the results of research work. Exchange of results of R&D projects through technical reports will be of immense use for utilization of the results by the industries. Some of the projects, which are fit for know-how transfer, may have to be screened. The preparation of welding hand books and welding data books also need special consideration.

Organized availability of information through website, database, CD will be of immense use for practicing engineers. There is a need to compile welding directory for the benefit of welding personnel.

Since most of the R&D projects will take about 3 years time for getting useful results allotment of funds requires proper planning. This may be possible by identifying the thrust areas and appointing a steering committee.

It is also necessary to avoid duplication of R&D efforts, as in our country we cannot afford duplication of projects.

Members from DST, CII, WRI & IIW can form a high level steering committee, which will approve the R&D projects and allocate the required funds. This committee also can identify project-monitoring groups for successful completion of R&D projects.

It is important to select projects of national importance by organizing workshops where industrial representatives, personnel from R&D labs and academic institutions, will be present to exchange the information.

By taking joint projects between metal producers, consumable and welding equipment manufacturers and industries, we will be able to have very useful results, which will be of immediate use to the industry. ■